UNIVERSITY OF CALIFORNIA PUBLICATIONS

COLLEGE OF AGRICULTURE

AGRICULTURAL EXPERIMENT STATION

BERKELEY, CALIFORNIA

Trials with California Silage Crops for Dairy Cows

BY

F. W. WOLL AND E. C. VOORHIES

BULLETIN No. 282

August, 1917

UNIVERSITY OF CALIFORNIA PRESS

BERKELEY

1917

BENJAMIN IDE WHEELER, President of the University.

EXPERIMENT STATION STAFF

HEADS OF DIVISIONS

THOMAS FORSYTH HUNT, Director.
EDWARD J. WICKSON, Horticulture (Emeritus).
HERBERT J. WEBBER, Director Citrus Experiment Station; Plant Breeding.
HUBERT E. VAN NORMAN, Vice-Director; Dairy Management.
WILLIAM A. SETCHELL, Botany.
MYER E. JAFFA, Nutrition.
*ROBERT H. LOUGHRIDGE, Soil Chemistry and Physics (Emeritus).
CHARLES W. WOODWORTH, Entomology.
RALPH E. SMITH, Plant Pathology.
J. ELIOT COIT, Citriculture.
JOHN W. GILMORE, Agronomy.
CHARLES F. SHAW, Soil Technology.
JOHN W. GREGG, Landscape Gardening and Floriculture.
FREDERIC T. BIOLETTI, Viticulture and Enology.
WARREN T. CLARKE, Agricultural Extension.
JOHN S. BURD, Agricultural Chemistry.
CHARLES B. LIPMAN, Soil Chemistry and Bacteriology.
CLARENCE M. HARING, Veterinary Science and Bacteriology.
ERNEST B. BABCOCK, Genetics.
GORDON H. TRUE, Animal Husbandry.
JAMES T. BARRETT, Plant Pathology.
FRITZ W. WOLL, Animal Nutrition.
WALTER MULFORD, Forestry.
W. P. KELLEY, Agricultural Chemistry.
H. J. QUAYLE, Entomology.
D. T. MASON, Forestry.
J. B. DAVIDSON, Agricultural Engineering.
ELWOOD MEAD, Rural Institutions.
H. S. REED, Plant Physiology.
W. L. HOWARD, Pomology.
†FRANK ADAMS, Irrigation Practice.
C. L. ROADHOUSE, Dairy Industry.
WILLIAM G. HUMMEL, Agricultural Education.
JOHN E. DOUGHERTY, Poultry Husbandry.
S. S. ROGERS, Olericulture.
DAVID N. MORGAN, Assistant to the Director.
Mrs. D. L. BUNNELL, Librarian.

DIVISION OF ANIMAL HUSBANDRY

GORDON H. TRUE
F. W. WOLL
J. I. THOMPSON
R. F. MILLER
E. C. VOORHIES
R. P. ROYCE
CORA J. HILL

* Died July 1, 1917.

† In co-operation with office of Public Roads and Rural Engineering, U. S. Department of Agriculture.

Trials with California Silage Crops for Dairy Cows

BY

F. W. WOLL AND E. C. VOORHIES

In the central and eastern states where the silo first became generally introduced on dairy and stock farms, Indian corn is by far the most important silage crop. This is at the present of minor importance as a forage crop in this state and will probably always remain so; we have, on the other hand, a number of other crops that have proved well adapted for the silo, especially varieties of the sorghum family, both of the saccharine and non-saccharine sorghums; also small grains, Sudan grass, rye grass and clover, alfalfa, etc. Considerable practical experience with most of these crops has been accumulated by this time, as regards their adaptability for the silo and the value of the resulting silage. Accurate experimental data bearing on these questions are, however, still limited, in spite of the interest in the subject among dairy farmers and stock men and its importance to them.

In order to furnish reliable information as to the value of these silage crops, especially to the dairy farmer, the Animal Husbandry Division of the College has conducted a series of siloing and feeding experiments with a number of the crops mentioned during the past four years. This bulletin presents brief accounts of these experiments and such general discussions of the subject as are deemed of direct value to our farmers. Circular 138 of the College of Agriculture, entitled "The Silo in California Agriculture," furnishes information on the general subject of the making and feeding of silage, and only conditions peculiar to the special crops mentioned will be discussed in this bulletin.

During the period given, trials have been conducted at the University Farm with the following silage crops: Indian corn, milo, feterita, sweet sorghum, alfalfa, Sudan grass, green oats and barley (volunteer grain), and more or less extended feeding experiments with these crops have been made with a view to determining their value to the dairy and stock farmer. It has not been practicable to make detailed studies of the chemical changes involved in the siloing of these crops, or the losses of feed components in the siloing process, but samples of the green forage crops and of the resulting silage have been taken in all cases and have been analyzed in the Nutrition Labor-

atory at Berkeley, through the kind assistance of Professor M. E. Jaffa, chief of the laboratory.

SILOS AT THE UNIVERSITY FARM

The silo equipment of the University Farm during the past three years has consisted of the four silos described in the circular referred to above,[1] and of an Ideal Green-Feed Silo, erected October, 1915, near the beef barn (dimensions 14 by 36 feet; cost of silo, complete with roof and anchors, $281.95). With the four silos previously built, this gives us a total theoretical silo capacity of nearly 600 tons of corn silage, or slightly over 400 tons in case of silage crops that do not pack as well as Indian corn. Since most tables of silo capacities are constructed on the basis of data obtained with Indian corn cut at a rather early stage of growth, the figures will be 20 to 30 per cent lower in the case of lighter materials containing less water or composed of finer stems and leaves than Indian corn. Under our climatic conditions the system of crop production can, however, be readily arranged so that silos may be filled twice a year, and a given silo capacity thus doubled.

The following two tables will show the main facts relating to the silage crops during the past two seasons. It will be noted that the following crops were siloed during the season of 1915: Indian corn, milo, feterita, and sweet sorghum, and in 1916, Indian corn, alfalfa, Sudan grass, feterita, and sweet sorghum. The crops were in all cases grown on grain land and were, therefore, planted later in the season than would be the case on spring-plowed land. The yields per acre of the various crops, dates of planting, irrigation and harvesting and total green forage placed in the silos are given in all cases.[2]

The average yields per acre of the different crops during the two seasons are as follows: Indian corn, 10.2 tons, milo, 11.3 tons, feterita, 10.0 tons, Sudan grass, 12.2 tons, and sweet sorghum, 14.7 tons (Early Amber, 13.4, Honey, 19.3, and Orange, 22.7). These figures are for crops grown on dry land or receiving one irrigation only. Since the rainfall for the two seasons from which the data were obtained was about normal, the figures may be taken to represent approximately the yields of the various crops that may be expected under conditions similar to those prevailing in central Sacramento Valley in case of clay loam soils in a good state of fertility.[3]

---

[1] Circular 138, p. 13.

[2] The data as to growing of crops and filling of the silos have been furnished by Professor Thomas Tavernetti, assistant to Dean of University Farm School.

[3] Bull. 278, Coll. of Agric., Univ. of Calif., p. 343.

TABLE I.—SILAGE AT UNIVERSITY FARM, 1915

No. Silo	Silage crop	Average Yield per acre, tons	Cost per ton for filling silo	No. of field	Date planted	Date harvested	Date irrigated	Tons put into silo
1. Concrete silo, dairy barn	Indian corn	9.42	$1.08	5*	May 1	Sept. 1	Early Leaming and U. S. 160. One irrigation, July 9	106.61
2. Remco silo	Indian corn	9.42	1.08	5	May 1	Sept. 1	Early Leaming. One irrigation, July 9	56.00
3. Ideal green-feed silo (12′)	Milo	11.27	.92	4	May 22	Sept. 22	No. 4 irrigated July 28; orchard not irrigated	63.07
4. Re-saw silo	Feterita	10.0	.83	4	May 22	Oct. 11	Irrigated July 28	49.84
5. Ideal green-feed silo (14′) beef barn	Sweet Sorghum	14.1	1.00	4	May 24	Oct. 15	Irrigated July 28	91.78

Remarks.—Average data for both fields for yields and cost of filling silo. No. 1 came from three lots, viz., U. S. I. Div., part of field No. 5 in U. S. No. 160, and part in Early Leaming. The above figure is the average for all of field No. 5. No. 3, the orchard plot averaged 13½ tons per acre, while No. 4 gave 9.73 tons. The cost for filling includes men and board, horses, labor and fuel for engine.

* And U. S. I. Div.

TABLE II.—SILAGE AT UNIVERSITY FARM, 1916

Silo	Silage crop	Yield per acre,	Date planted	Date harvested	Date irrigated	Tons in silo	Remarks
Remco	Alfalfa	6.1	1st cutting	Mar. 27–31	.....	64.46	Alfalfa green and watery, very weedy; foxtail fully headed
Ideal green-feed silo	Sudan grass	12.2	June 15	Sept. 25	.....	61.80	Fully ripe when siloed; not irrigated after planting
Concrete silo, dairy barn	Indian corn	.....	.....	Sept. 16	.....	90.70	Mixed lots of sweet corn and Early Leaming.
Concrete silo, dairy barn	Indian corn	13.3	June 21	Oct. 25	Aug. 9	110.25	Early Leaming (2d crop, after barley)
Ideal green-feed silo, beef barn	Indian corn	13.9	June 21	Oct. 26	Aug. 11	87.23	Reid's Yellow Dent (2d crop, after barley)
Re-saw	Feterita	10.0	May 22, '15	Oct. 11, '15	July 28, '15	49.84	Silo opened Sept., 1916
Remco	Sweet sorghum	19.3	June 17	Nov. 2	Aug. 11	72.93	Rather green, frosted
Re-saw	Sweet sorghum	18.2	June 17	Nov. 6	Aug. 11	75.23	

Data for average yields of dry matter and of digestible feed components calculated on basis of average gross yields and percentage dry matter and estimated digestible matter in the crops, are presented in the following table. The figures given will indicate the relative value of the respective silage crops for feed production.

TABLE III.—AVERAGE YIELDS OF SILAGE CROPS PER ACRE, 1915–1916

	Tonnage	Dry matter, pounds	Digestible matter, pounds
Indian corn	10.2	6622	4106
Sweet sorghum	14.7	5822	3318
Milo	11.3	5990	3294
Feterita	10.0	8740	4804
Sudan grass	12.2	4442	2530

The per acre yield of dry matter and total digestible matter for feterita was higher than that of the other varieties, Indian corn coming second, with milo, sweet sorghum, and Sudan grass following in the order given. The feterita did not give as high tonnage as the other silage crops, but the crop contained a considerably higher percentage of dry matter at the time of harvest than any of the other crops, viz., 43.7 per cent, against 25.5 per cent for Indian corn, 34.1 per cent for Sudan grass, 26.5 per cent for milo, and 19.75 per cent as the average for the sweet sorghum varieties. The feterita silage, on the other hand, was less palatable to stock than any of the other silages, in part at least due to the advanced stage of growth at which the crop was siloed. The heads made up about 28 per cent of the total weight of the crop at the time of cutting, when the seed was hard and fully matured. Water was added to the green forage as it went into the silo. The resulting silage was of good clean flavor, of medium acidity and free from molds, but as suggested, was not eaten by the stock as readily or in as large amounts as other kinds of silage. With our present limited experience with this silage, it cannot be stated definitely whether a better quality, so far as palatability goes, might be obtained if the crop was siloed before the seed was fully matured or if more water be added during the filling of the silo. It may be said in general, however, that all the above crops experimented with will make satisfactory silages and that the particular crop which is likely to do best in each locality should be grown for the silo. So far as palatability and general value as a silage crop goes, our present experience would lead us to put Indian corn first for irrigated land, with sweet sorghum a close second, while for dry farming or with a limited water supply, the grain sorghums (milo and feterita) or

Sudan grass may be placed first. In regard to the latter crop, it should be stated that a second hay or pasture crop may ordinarily be counted on under the conditions prevailing in the interior valleys, so that this crop would be of relatively greater value for the production of stock feed than would appear from the figures given in the preceding table.

FEEDING EXPERIMENTS WITH SILAGE CROPS

The feeding experiments described in the following pages were conducted with cows in the University dairy herd during the past four years in studying the relative value of different kinds of silage to the dairy farmer, viz.:

1. Indian corn silage as a supplement to alfalfa hay.
2. Milo silage as a supplement to alfalfa hay.
3. The comparative value of silage made from Indian corn and that from Sudan grass and from sweet sorghum.

The first of these experiments was conducted November, 1913 to March, 1914; the experiment with milo silage, January to April, 1915; and those with Sudan grass and sweet sorghum silage during the past season, November, 1916 to April, 1917.

The experiments differ somewhat in plan and scope, due to differences in the special conditions under which each one was conducted. The University dairy herd, like those of similar institutions, serves a four-fold purpose, being used as instructional material, for the production of milk, and of breeding stock of high quality, and for experimental purposes in the study of nutrition problems and feeding practices. It is evident that experimental work conducted with the herd must be planned and conducted with a view to its bearing on the other purposes for which the herd is kept. The experiments described in this bulletin are not, therefore, necessarily such in scope or details as the authors would like to have them, but they were arranged each year in such a way as to furnish the most satisfactory solution of the problem studied which the conditions then prevailing would permit. In the conduct of the experiments, many thousands of weighings of milk, feed, and animals, as well as Babcock tests, and lactometer readings have been made, the complete record of which would fill a large volume. Only summary figures for groups of cows for each period of the various experiments are, however, given in this bulletin, so as not to increase unduly the size and the cost of the publication, and in order to facilitate the study of the results obtained and the deductions drawn from them.

TABLE IV.—COMPOSITION OF FEEDING STUFFS FED IN SILAGE EXPERIMENTS, 1913–17, IN PER CENT

Name of feed	Moisture	Protein	Fat	Fiber	N-free extract	Ash	Total digestible matter	Digestible Protein	Digestible Carbohydrates and fat
I. Corn silage experiment, 1913–14									
Alfalfa hay	17.57	14.08	1.81	25.41	33.70	7.43	49.4	10.0	36.8
Indian corn silage	73.07	2.69	.71	5.72	15.75	2.06	17.8	1.4	16.3*
Wheat bran	11.48	14.08	3.81	8.70	55.54	6.39	57.5	11.0	48.6
Rolled oats	12.27	7.80	4.20	8.40	63.45	3.88	61.4	6.1	62.6
Rolled barley	9.85	13.20	2.00	5.00	67.62	2.33	79.3	10.3	68.6
Linseed meal	10.50	33.55	8.45	7.69	33.97	5.84	70.7	29.9	47.8
Cocoanut meal	11.64	21.35	10.30	9.01	42.32	5.38	72.5	19.2	62.1
II. Milo silage experiment, 1915									
Milo silage	73.50	1.35	.65	4.50	17.85	2.15	14.6	.7	14.4†
Alfalfa hay	15.70	13.33	1.54	22.41	40.30	6.72	50.6	9.5	40.0
Rolled barley	12.14	9.90	2.44	5.75	66.87	2.90	77.4	7.7	67.1
Cocoanut meal	13.79	10.19	7.02	7.70	46.21	6.09	70.7	17.3	57.8
Dried beet pulp	11.00	7.92	.20	20.03	57.59	3.26	66.8	4.1	64.4
III. Sudan grass and sweet sorghum silage experiments, 1916–17									
Sudan grass silage	69.00	2.03	.61	10.50	14.96	2.90	17.7	1.0	16.4‡
Sweet sorghum silage	78.27	1.44	.45	6.80	11.20	1.85	12.4	.7	11.7‖
Indian corn silage	74.85	1.57	1.11	6.88	13.72	1.87	16.6	.8	16.6¶
Alfalfa hay	8.50	15.59	1.29	27.53	38.47	8.62	54.9	11.1	40.6
Wheat bran	9.96	11.85	3.89	10.75	57.42	6.13	58.5	9.2	50.2
Rolled barley	7.72	11.93	2.25	6.74	68.50	2.86	81.2	9.3	70.9
Rolled oats	11.07	7.18	5.83	14.22	58.15	3.55	62.2	5.6	63.6
Cocoanut meal	8.14	18.83	7.48	9.68	49.55	6.32	75.4	16.9	62.2
Dried beet pulp	7.47	6.39	.94	17.90	63.34	3.96	69.4	3.3	67.5
IV. Alfalfa silage experiment, 1916 (to be reported later)									
Alfalfa silage	81.03	2.69	.98	2.32	10.55	2.43	11.4	1.5	10.3
Feterita silage	58.30	3.63	1.00	8.30	25.82	2.95§	23.8	1.9	22.6
Alfalfa hay	8.50	18.18	3.28	26.33	41.09	8.35	54.9	12.2	41.1
Rolled barley	7.72	11.93	2.25	6.74	68.50	2.86	81.2	9.3	70.9
Wheat bran	8.41	13.79	4.66	10.41	56.18	6.55	59.5	10.8	50.8
Dried beet pulp	7.07	8.32	.84	20.30	60.46	3.01	69.7	4.3	67.0
Cocoanut meal	7.20	19.69	8.80	20.14	37.08	7.09	76.1	17.7	66.7

* Fixed acids 2.09 per cent, volatile acids .41 per cent.
† Fixed acids 1.42 per cent, volatile acids .63 per cent.
‡ Fixed acids 31 per cent, volatile acids .25 per cent.
‖ Fixed acids 1.22 per cent, volatile acids .51 per cent.
¶ Fixed acids .86 per cent, volatile acids .54 per cent.
§ Fixed acids 1.02 per cent, volatile acids .50 per cent.

The chemical composition of the feeding stuffs used in the various experiments will be seen in table IV. The calculated digestible components of the feeds are also given, based on average digestion coefficients for the different feeds, or for feeds of similar character, in cases where no digestion trials have been conducted.

I. INDIAN CORN SILAGE AS A SUPPLEMENT TO ALFALFA HAY

Alfalfa is the most important single feed in the main dairy sections of the state, outside of the northern and central coastal counties. It forms the sole feed of the cows in the large majority of cases, being generally either pastured or fed green in corrals, or fed as hay during the winter months. There is perhaps no better single dairy feed than alfalfa, and rich alfalfa pasture or a good quality of green alfalfa or of alfalfa hay can hardly be improved upon for feeding dairy cows, except in the case of heavy-producing cows which will be likely to give good returns for additional grain feed.

Experiments conducted in the University dairy herd during 1913 and 1914 led to the conclusion that on account of the increased production obtained and the residual effect of the grain feeding, as well as its favorable influence on the condition of the cows and their offspring, the practice of feeding grain to cows on alfalfa is economically sound and may be recommended.[4] This holds true especially for heifers and young cows, and for heavy-producing animals, which cannot be brought to a maximum production on roughage alone, even if this be as excellent and palatable a feed as green alfalfa or good alfalfa hay. In the case of such cows it is, therefore, advisable to add to the rations at least small amounts of feeds furnishing nutrients in a more concentrated form than in either green or dry coarse feeds, like cereal grains, mill feeds, etc.

With the introduction of the silo on dairy farms and the growing of silage crops, like Indian corn, sorghum varieties, etc., another variation in the practice of feeding cows is rendered possible. These silage crops are of a starchy composition and relatively low in protein (flesh-forming substances), hence supplement well the nutrients in the alfalfa and widen the nutritive ratio of the ration fed, making these conform more closely to accepted feeding standards than alfalfa alone. The practice of feeding silage as a supplementary feed to alfalfa has been adopted by dairy farmers in different sections of the state and appears to be gaining ground. The experiment described below was planned to furnish accurate information as to the value of this method

[4] See Bull. 256, Calif. Agr. Coll., p. 443 et seq.

of feeding and is the first experimental study ever conducted of the general value of this method of feeding dairy cows under conditions like those prevailing in this state.

PLAN OF THE EXPERIMENT

Twenty-six cows in the University dairy herd were separated into two lots of thirteen each. The lots were made as even as possible as regards breed, age, and body weight of cows, dairy production, and distance from last and following freshening. They were fed as follows during three periods of four weeks each, a preliminary feeding period of one week preceding each period, in order to accustom the cows to the rations fed during the subsequent periods.

Lot A—Alfalfa hay and Indian corn silage throughout the experiment.

Lot B—Alfalfa and corn silage during Periods I and III, alfalfa hay as sole roughage during Period II.

Eight of the cows in each lot were fed a grain mixture composed of approximately equal parts by weight of wheat bran, rolled barley and oats, with small amounts of linseed meal and cocoanut meal, while the others received rough feeds only. The cows were fed grain in proportion to their production; as a general rule, one pound for every four or five pounds of milk produced. The method of feeding and care of the two lots was as similar as possible, with the exception stated regarding the roughage fed.

The routine of conducting the experiment and the general handling of the cows were otherwise as in the case of the general University dairy herd, which has already been described in the bulletin referred to above. Each milking from the individual cows in the experiment was weighed and sampled, and separate composite samples of each cow's milk were tested once a week. The cows were all in the early or middle part of their lactation periods at the beginning of the experiment, and those bred were at that time, on the average, about five and one-half months from the next freshening. Lot A contained two Holsteins, four Guernseys, two Jerseys and five grades, and Lot B, three Holsteins, five Guernseys, one Jersey and four grades. The average production, body weight, age, etc., for the cows in the two lots at the beginning of the experiment were as follows:

TABLE V.—AVERAGE DATA FOR COWS AT THE BEGINNING OF THE EXPERIMENT

	Lot A	Lot B
Milk per week, pounds	143.7	143.6
Solids per week, pounds	19.7	19.2
Fat, pounds	6.49	6.42
Average per cent solids	13.7	13.3
Average per cent fat	4.51	4.46
Average body weight, pounds	1047	1164
Average age, years	4.7	5.2

The experiment was conducted from November 20, 1913, to March 5, 1914. All the cows were apparently in good health and ate their feed with relish throughout the experiment. This progressed as planned without any serious accident, except that four of the cows (one in Lot A and three in Lot B) decreased more rapidly in their flow of milk than anticipated and were, therefore, taken off the experiment during the last period.

TABLE VI.—AVERAGE FEED CONSUMPTION, BODY WEIGHT, AND PRODUCTION OF COWS

Lot A	Period I	Period III	Av. Period I and III	Period II	Difference betw. ave. of Per. I and III and Per. II
Feed consumption per day, lbs.	Alfalfa and Silage				
Hay	14.4	10.2	12.3	12.2	+ .1
Silage	29.4	31.9	30.7	33.9	— 3.2
Grain	2.3	2.8	2.6	2.6	....
Body weight, lbs.	1040	1044	1042	1045	— 3.
Production per cow and per day					
Milk, lbs.	19.2	18.4	18.8	19.3	— .5
Solids, per cent	13.9	13.7	13.8	13.7	+ .1
Solids, lbs.	2.67	2.52	2.60	2.64	— .04
Butter fat, per cent	4.55	4.35	4.44	4.36	+ .08
Butter fat, lb.	.87	.80	.84	.84	.....
Lot B					
Feed consumption per day, lbs.	Alfalfa and Silage			Alfalfa only	
Hay	14.4	10.2	12.3	21.0	— 8.7
Silage	29.7	31.4	30.6	.....	+30.6
Grain	2.3	3.3	2.8	2.7	+ .1
Body weight, lbs.	1155	1069	1112	1078	+34.
Production per cow and per day					
Milk, lbs.	19.3	17.8	18.6	15.9	+ 2.7
Solids, per cent	13.7	13.9	13.8	13.7	+ 1.
Solids, lbs.	2.63	2.47	2.55	2.18	+ .37
Butter fat, per cent	4.45	4.45	4.45	4.61	— .16
Butter fat, lb.	.86	.79	.83	.7.	. .10

The data presented in table VI give the average results obtained during the three periods of the experiment for both lots, the daily feed ration and the production of milk and butter fat per head being given in each case.

Considering first the data for Lot B, we note that, on the average for all cows, the production was as follows: for *milk,* Period I, 19.3 pounds; Period III, 17.8 pounds, and Period II (no silage), 15.9 pounds, and for *butter fat,* .86, .79, and .73 pound, for Periods I, III, and II, respectively. The production of milk was 2.7 pounds lower and that of butter fat .10 pound lower during the second period than the average data for the preceding and following periods when silage was fed. The figures for Lot A show that a similar number of cows as in Lot B fed alfalfa and silage throughout the experiment, averaged .5 pound higher in milk during Period II than the average of Periods I and III, while no difference occurred in the production of butter fat. As the two lots were very uniform as regards the various factors that influence milk secretion, we may be justified in considering that the average milk production of the cows in Lot B, if these had been fed similarly throughout the experiment, would also have decreased .5 pound per head daily during Periods I and III, as compared with Period II, and the production obtained should, therefore, be corrected accordingly. This gives us an increase in the milk production of 2.2 pounds and of butter fat .10 pound during Periods I and III, as compared with Period II; that is, on account of the feeding of silage and alfalfa hay (with or without accompanying grain), the production of milk and butter fat was raised by 14 per cent over the corresponding data for the period when alfalfa hay only was fed.

Whether the observed improved nutritive effect of the silage rations over those containing dry feed only was due to a larger supply of digestible nutrients, or to a stimulating effect of the succulent feed on the milk secretion will be discussed below in connection with the composition of the rations fed, but so far as the practical aspects of the case go, the evidence seems clear that an appreciable improvement in production was obtained as a result of a partial substitution of corn silage in the ration of alfalfa hay, or alfalfa and grain.

Since ten of the cows in the experiment were fed alfalfa hay only, and the balance (sixteen), alfalfa and grain, the data secured supply information as to the effect of the addition of silage to the ration in either case. These data have been compiled for the different cows, with results as shown in the following table:

	Milk, lbs.	Solids, lbs.	Fat, lb.
Cows fed roughage and grain			
Average of Periods I and III (alfalfa and silage)	17.7	2.46	.81
Average of Period II (alfalfa only)	17.2	2.40	.82
Difference	+.5	+.06	—.01
In per cent	3	3	1
Cows fed roughage only			
Average of Periods I and III (alfalfa and silage)	17.7	2.43	.80
Average of Period II (alfalfa only)	14.1	1.91	.63
Difference	+3.6	+.52	+.17
In per cent	26	27	27

Both in the case of the cows receiving grain and of those fed roughage only, very nearly similar amounts of dry matter were supplied in the rations whether or not silage was fed. In the case of cows fed grain, there was, however, only a slight increase in the production of milk or milk components when silage was included in the rations of the cows, viz., 1 to 3 per cent. The cows receiving alfalfa hay only, on the other hand, responded in a striking manner to the addition of silage to the ration, the production of milk being increased, on the average, from 14.1 pounds to 17.7 pounds per head daily, that of solids from 1.91 to 2.43 pounds, and that of butter fat from .63 to .80 pound, an increase in each case of 26 to 27 per cent. By referring to the summaries of results for all the cows on the experiment on page 28 it will be noted that an increase in production of about 14 per cent was obtained for all the cows. In view of the insignificant improvement in production by the cows fed grain, this increase evidently came through the effect of the introduction of silage in the rations of the cows receiving roughage only.

The results obtained in this single experiment suggest that the feeding of silage to cows on roughage (alfalfa hay) only will produce a marked improvement in production, while only slightly larger yields can be expected through the addition of silage to rations containing a medium allowance of grain feeds (average, 4.5 pounds per head daily). It is perhaps significant that the cows in this experiment were fed alfalfa hay of fair quality *ad lib.* If a less valuable forage had been fed along with the grain, or the amount fed had been reduced below what the cows were able to consume with a good appetite, it is very likely that the addition of silage to the ration would have been found of decided advantage also in the case of grain-fed cows.

According to the data given in table VII, the rations fed to the cows in this experiment contained the amounts of nutrients shown below during the different periods.

TABLE VII.—COMPOSITION OF RATIONS FED TO COWS, IN POUNDS

	Dry matter	Digestible Protein	Digestible Carbohydrates and fat	Nutr. ratio, 1:
Lot A				
Periods I and III (silage throughout)	20.7	1.92	11.06	5.8
Period II	21.5	1.95	11.55	5.9
Difference	—.8	—.03	—.49	
Lot B				
Periods I and III	20.8	1.94	1.117	5.8
Period II (no silage)	19.7	2.37	9.32	3.9
Difference	+1.1	—.43	+1.85	
Corrected	+.3	—.46	+1.36	

The cows in Lot B received somewhat more dry matter and digestible carbohydrates and fat in their rations during Periods I and III (dry feed and silage), than during Period II (dry feed only), but the amount of digestible protein was considerably lower during Periods I and III than during Period II, the nutritive ratio for the former rations being 1:5.8 and for Period II, 1:3.9. By introducing silage in the rations fed, the nutritive ratio of these were, therefore, changed from very narrow to medium, *i.e.*, one approximately in accordance with that of the common feeding standards for dairy cows.

If the production of milk and milk components by the cows per 100 pounds of dry matter eaten during the different periods be calculated, comparative figures for the efficiency of the different rations will be obtained. The following table presents the data with regard to this point.

TABLE VIII.—RETURNS PER 100 POUNDS OF DRY MATTER EATEN, LOT B

	Milk, lbs.	Solids, lbs.	Fat, lbs.
Periods I and III	89.4	12.3	3.99
Period II	80.7	11.1	3.71
Difference	+8.7	+1.2	+.28
Corrected	+9.7	+1.5	+.43
In per cent	11	12	11

The differences in production observed have been corrected in the last but one line of the table, in accordance with the findings for Lot A, which showed that the cows produced 1.0 pound more milk, .3 pound more solids and .15 pound more butter fat per 100 pounds dry matter in the rations during Periods I and III than during Period II, and the percentage differences have been calculated on basis of the

corrected figures. It will be noted that these show an increase of 11 to 12 per cent in the efficiency of the average rations fed during Periods I and III over the rations fed during Period II. There was no appreciable difference in the relative efficiency of the rations as to the production of the cows that received grain and those fed rough feeds only. Whether the improvement in the silage ration noted is due to the wider nutritive ratio fed during the former period or to a superior nutritive effect of the silage rations, cannot be decided by the results of this experiment alone. This question will, however, be further discussed in connection with the other silage experiments reported in this bulletin.

II. MILO SILAGE AS A SUPPLEMENT TO ALFALFA HAY

This experiment was conducted with eighteen cows in the University dairy herd from January 14 to April 29, 1915. Owing to the relatively small number of cows in the herd available for an experiment of this kind during the season of 1914–15, it was decided to feed all cows on the experiment alike, in so far as the kinds of feeds go, except that ten of the cows received rough feed and grain, and the others, which were rather advanced in their lactation period and were low producers, received roughage only. The cows were fed as follows during three periods of four weeks each: Periods I and III, milo silage and alfalfa hay; Period II, alfalfa hay. A week's preliminary feeding preceded each period.

The plan of the experiment was, in general, similar to that of the preceding one. The silage and alfalfa hay were fed according to the capacity of each cow for consuming roughage, while the amounts of concentrates fed to ten of the cows in the experiment varied from three to six pounds per head daily, according to their dairy production. The concentrates fed consisted of a mixture of rolled barley, cocoanut meal and dried beet pulp, in the proportion of 1:2:1 by weight. Five of the cows were pure-bred Holsteins, three were pure-bred Jerseys, one pure-bred Guernsey, two pure-bred Ayrshires, and three grade Shorthorns. The cows averaged 1174 pounds in weight at the beginning of the experiment, and produced, on the average, 25.6 pounds milk and 1.1 pounds butter fat per head daily.

Data of the average body weights, production, and feed consumption of the cows for each period of the experiment are given in table IX.

TABLE IX.—MILO SILAGE FOR DAIRY COWS

Feed consumption per day, lbs.	Period I	Period III	Av. Period I and III	Period II	Difference
	Alfalfa and milo silage			Alfalfa	
Hay	9.4	11.1	10.2	23.0	—12.8
Silage	27.2	38.0	32.8	.....	+32.8
Grain	3.1	3.1	3.1	3.0	+ .1
Body weight, lbs.	1090	1091	1090	1071	+19.
Production per cow and per day					
Milk, lbs.	23.1	15.9	19.5	20.3	— .8
Solids, lbs.	2.99	2.08	2.53	2.57	— .04
Solids, per cent	12.9	13.0	12.9	12.7	+ .2
Butter fat, lb.	.934	.658	.796	.805	— .009
Butter fat, per cent	4.05	4.13	4.08	3.95	+ .13

The average production of the cows on the two kinds of rations was so nearly alike that one would be justified in considering the rations of similar feeding value. The average milk yield was slightly lower for Periods I and III (silage rations) than for Period II (dry feed only), but the quality of the milk produced on the former rations was somewhat improved over that of the milk produced during Period II, making the average production of fat and other milk solids practically the same for the two kinds of rations.

The chemical composition of all feeds used in the experiment, and their digestible components, will be seen from table III. The amounts of dry matter and digestible components in the rations fed during the different periods of this experiment calculated from the data referred to, are shown in table X.

TABLE X.—COMPOSITION OF AVERAGE RATIONS FED, IN POUNDS

	Dry matter	Total digestible matter	Digestible		Nutr. ratio, 1:
			Protein	Carbohydrates and fat	
Period I (alfalfa and milo silage)	17.8	11.0	1.45	9.60	6.6
Period III (alfalfa and milo silage)	22.2	13.3	1.69	11.83	7.0
Average	20.0	12.2	1.57	10.72	6.8
Period II (alfalfa)	22.0	13.7	2.55	11.06	4.3
Difference	—2.0	—1.5	—.98	—.34	....

If the amounts of dry matter in the rations be compared with the production of milk and milk components, the data shown in table XI will be obtained.

TABLE XI.—PRODUCTION PER 100 POUNDS DRY MATTER IN RATIONS

	Milk, lbs.	Solids, lbs.	Butter fat, lbs.
Periods I and III (alfalfa and milo silage)	97.5	12.7	3.98
Period II (alfalfa)	92.3	11.7	3.66
Difference	—5.2	—1.0	—.32
In per cent	5	8	8

The nutritive effect of the silage rations was, therefore, 5 to 8 per cent higher than that of the same rations without the silage. This is not as marked an improvement as in the preceding experiment for Indian corn silage (11 to 12 per cent). If the results obtained with the cows that received roughage only be calculated in a similar way, we find that 100 pounds of dry matter in the rations of these cows produced 91.4 pounds milk, 11.7 pounds solids and 3.71 pounds fat during Periods I and III, and 83.7 pounds milk, 10.6 pounds solids and 3.37 pounds fat, an increase of 8, 9, and 11 per cent respectively. Also in the case of these cows, the average production on the silage rations differed but slightly from those fed during the intermediate period when the cows received dry roughage only, in fact there was a slight decrease in production. Results with the corn silage in the preceding experiment were not, therefore, corroborated in this case. But when the production of milk or milk components per unit of dry matter supplied in the rations is considered, it is shown that somewhat better returns were obtained by supplementing the alfalfa rations with milo silage in case of the cows receiving roughage only, than where the rations were composed of rough feeds and grain.

III. SUDAN GRASS AND SWEET SORGHUM SILAGE VS. INDIAN CORN SILAGE

This experiment was intended to furnish accurate information regarding the comparative value of Indian corn silage and silage made from Sudan grass or sweet sorghum, for milk production.

A. SUDAN GRASS SILAGE VS. INDIAN CORN SILAGE

Sudan grass is a relatively new crop in this state and but little is known as to its exact value for different classes of farm stock and for different purposes.[5] No information is available as to its value as a silage crop, the siloing experiment with this crop last year being, so far as is known, the first one of the kind ever conducted. Under these

[5] See Bulletin 277 of this College, on "Sudan Grass," for a discussion of the general value of this promising forage crop.

conditions it seemed especially desirable to secure reliable data as to the adaptability and value of the silage for feeding dairy cattle and the experiment here reported was accordingly planned.

The experiment with Sudan grass silage was conducted from September 28, 1916, to January 4, 1917, with twenty-one cows in the University dairy herd, viz., eighteen pure-breds and three grades, the different breeds being represented as follows among the former: one Ayrshire, eight Jerseys, four Guernseys and five Holsteins, while the grades were all Holsteins. All the cows but two were fresh or in the early part of their lactation periods at the beginning of the experiment. The average daily production of the cows at this time was 27.8 pounds milk, 2.41 pounds solids, and 1.00 pound butter fat. The experiment was similar to the preceding ones in plan and conduct, three periods of four weeks' duration being arranged for, each one introduced by a week's preliminary feeding. The cows were fed alfalfa hay *ad lib.* and a grain mixture of dried beet pulp, cocoanut meal, wheat bran, and rolled barley (4:1:1:1, by weight), according to their production, on the average at the rate of one pound per five pounds of milk. One cow, a Holstein grade, received rough feed only. The more important results obtained in the experiment are presented in table XII, which includes average data for feed consumption, body weights, and production of milk, solids and butter fat.

In addition to alfalfa and concentrates, the cows received silage as follows: Periods I and III, Indian corn silage.
Period II, Sudan grass silage.

Table XII. Sudan Grass Silage for Dairy Cows

	Period I	Period III	Av. Period I and III	Period II	
Feed consumption per day, lbs.		Indian corn silage		Sudan grass silage	Difference
Alfalfa hay	23.8	11.6	17.7	21.6	—3.9
Corn silage	31.8	32.8	32.3	.....	....
Sudan grass silage	.....	.....	.....	23.2	....
Concentrates	6.8	5.8	6.3	5.9	+ .4
Body weights, lbs.	1174	1201	1187	1186	+1.
Production per cow per day					
Milk, lbs.	23.7	15.4	19.6	18.9	+ .7
Solids, lbs.	3.28	2.25	2.77	2.60	+ .17
Solids, per cent	13.8	14.6	14.1	13.8	+ .3
Fat, lbs.	1.06	.772	.916	.879	+ .037
Fat, per cent	4.47	5.01	4.67	4.65	+ .02

It will be noted that the difference in the nutritive effect of the two silage rations was but small and may be considered within the limits of experimental errors inherent in feeding trials of this kind.

There was a slightly larger production of milk, solids and butter fat during Periods I and III (*corn silage*) compared with Period II (*Sudan grass silage*), 3.6, 6.1, 4.0 per cent respectively, but less silage, somewhat less hay, and an average of .4 pound more concentrates per head were eaten daily during the latter period than the averages for the corn silage periods.

Evidently it is necessary to look into the contents of dry matter and separate feed components in the two rations to determine the efficiency of either for milk production. The results relative to this point are presented in table XIII.

TABLE XIII.—COMPOSITION OF AVERAGE RATIONS FED, IN POUNDS

	Dry matter	Total digestible matter	Digestible		Nutr. ratio, 1:
			Protein	Carbohydrates and fat	
Period I (corn silage)	36.1	23.2	3.54	19.20	5.4
Period III (corn silage)	24.2	15.9	2.10	13.78	6.6
Average	30.2	19.6	2.82	16.49	5.8
Period II (Sudan grass silage)	32.4	20.1	3.18	16.12	5.1
Difference	—2.2	—.5	—.36	+.37	

The corn silage rations contained, on the average, 2.2 pounds less dry matter and .5 pound less digestible matter than the Sudan grass silage rations and had only a slightly wider nutritive ratio (1:5.8, against 1:5.1 for the Sudan grass silage). If the production of the cows on the different rations be compared with the dry matter furnished during the three periods of the experiment, the data given in table XIV are obtained.

TABLE XIV.—RETURNS PER 100 POUNDS DRY MATTER, IN POUNDS

	Milk	Solids	Fat
Period I (corn silage)	65.6	9.09	2.94
Period III (corn silage)	63.6	9.30	3.19
Average	64.9	9.17	3.03
Period II (Sudan grass silage)	58.3	8.02	2.71
Difference	6.6	1.15	.32
In per cent	+10	+13	+11

A comparison of the amounts of dry matter contained in the rations fed and the average production of the cows, will show that about 10 per cent better results were obtained from the corn silage rations than from those containing Sudan grass silage. While a single experiment with only twenty-one cows does not furnish sufficient evidence for generalizations the conclusion is doubtless justified

from the experience gained in feeding Sudan grass silage during the past season, as well as from the results obtained in this experiment, that it furnishes a good quality of silage for dairy cows and that its nutritive effect will not fall far behind that of Indian corn, the standard silage crop of the country.

B. Sweet Sorghum Silage vs. Indian Corn Silage

On the completion of the preceding experiment, the cows included therein that still gave at least a fair amount of milk, and other cows in the University dairy herd that had recently freshened, were placed in a similar experiment as the last one, with sweet sorghum silage to be fed during the second period in place of Indian corn silage, which was fed during the preceding and the following period. The plan and conduct of the experiment was otherwise similar to the earlier ones of this series.

Twenty-eight cows were included in this experiment, viz., thirteen grades (twelve Holsteins and one Shorthorn) and fifteen pure-breds (two each of Ayrshires and Holsteins, five Guernseys and six Jerseys). The cows were about three months from calving, on the average, at the beginning of the experiment, and had an average daily production at that time of 17.5 pounds milk, 2.40 pounds solids, and .75 pound butter fat. All but three cows received concentrates in addition to alfalfa hay and silage. The grain mixture fed varied somewhat during the progress of the experiment, but was composed of the following average amounts of the various concentrates during the period given: dried beet pulp, 50 per cent; cocoanut meal, 25 per cent; wheat bran, 15 per cent, and barley and cottonseed meal 5 per cent each.

The experiment was commenced December 28, 1916, and continued until April 5, 1917. The average results obtained as to the feed consumption and the production of the cows are presented in table XV.

Here again only insignificant differences in the effect of the two silage rations on the production of the cows are to be observed. In fact, the results as to the amounts of feed eaten and of milk and milk components produced, as well as average body weights of the cows while on the two kinds of feed, were as nearly similar as might be expected if the cows had been fed the same rations throughout the experiment (p. 27). It remains to be seen whether any difference occurred in the amounts of dry matter or digestible components supplied in the two rations. As before the composition of the rations and the returns per hundred pounds of dry matter eaten, have been calculated, and the results will be found in table XVI.

TABLE XV.—SWEET SORGHUM SILAGE FOR DAIRY COWS

	Period I	Period III	Av. Period I and III	Period II	
		Indian corn silage		Sweet sorghum silage	Difference
Feed Consumption per day, lbs.					
Alfalfa hay	9.9	11.3	10.6	9.8	— .8
Indian corn silage	35.5	33.5	34.5	.....	....
Sweet sorghum silage	.....	.....	.....	35.4	....
Concentrates	8.8	7.6	8.2	8.4	— .2
Body weight, lbs.	1089	1124	1106	1098	— .8
Production per cow and per day					
Milk, lbs.	24.4	20.9	22.7	22.4	— .3
Solids, lbs.	3.27	2.81	3.04	2.96	— .08
Solids, per cent	13.4	13.4	13.4	13.2	— .2
Fat, lbs.	1.06	.89	.975	.977	— .002
Fat, per cent	4.34	4.26	4.30	4.36	— .06

TABLE XVI.—COMPOSITION OF RATIONS, IN POUNDS

	Dry matter	Digestible matter	Digestible: Protein	Digestible: Carbohydrates and fat	Nutr. ratio, 1:
Period I (corn silage)	26.1	17.5	2.33	15.5	6.6
Period III (corn silage)	25.7	17.1	2.37	15.0	6.3
Average	25.9	17.3	2.35	15.2	6.5
Period II (sweet sorghum silage)	24.4	15.7	2.26	13.5	6.0

RETURNS PER 100 POUNDS DRY MATTER

	Milk	Solids	Fat
Period I (corn silage)	93.5	12.5	4.06
Period III (corn silage)	81.3	10.9	3.46
Average	87.4	11.7	3.76
Period II (sweet sorghum silage)	91.8	12.1	4.00
Difference	—4.4	—.4	—.24
In per cent	5	3	6

The differences in the efficiency of the two silage rations for milk production as shown by the data given in the table are very small, viz., about 5 per cent, indicating that the sweet sorghum silage has a similar or slightly higher feeding value than Indian corn silage. This is only what might be expected: the chemical composition of the two kinds of feed is very nearly the same, and they differ but slightly in digestible components, nutritive ratio, acidity contents or palatability. Hence there is every reason to accept as conclusive the result of the preceding experiment regarding the general value of the two silages for milk production, and the choice of the crop to be grown for the silo may, therefore, be decided on the score of the maximum yields of feed

materials that may be secured and the labor of growing the crops under the special conditions of each locality.

In the preceding four experiments with silage crops, the influence of feeding silage made from Indian corn, milo, Sudan grass, and sweet sorghum to dairy cows has been studied, and the nutritive effect of rations composed of these silages with alfalfa hay, with or without accompanying grain, has been compared. The effect of the introduction of corn or milo silage in rations made up of either alfalfa alone or alfalfa and concentrates has also been studied. It has been shown that the silage increased the efficiency of the alfalfa rations, as judged from the amount of milk produced per hundred pounds of dry matter eaten, by 5 per cent and 11 per cent on milo and Indian corn silage rations, respectively, while the production of milk solids or butter fat was increased by about 10 per cent in either case. On the other hand, Indian corn silage produced about 10 per cent better returns per unit of dry matter in the rations than the Sudan grass silage, and sweet sorghum silage produced about 5 per cent better returns than Indian corn silage.

A study of the data presented in connection with the various experiments discloses the fact that the increased efficiency of the silage rations in the first two experiments was accompanied by a widening of the nutritive ratio of the rations fed, in the first experiment from 1:3.9 to 1:5.8, and in the second experiment from 1:4.3 to 1:6.8. The same was found in the case of the comparative trial of Sudan grass and corn silages; the wider nutritive ratio, 1:5.8 (corn silage ration) proved more efficient than the narrower one, 1:5.1 (Sudan grass). In the case of the sweet sorghum-corn silage experiment, a somewhat improved efficiency was, on the other hand, found in the case of the ration with the narrower nutritive ratio (sweet sorghum, 1:6.0; Indian corn, 1:6.5).

The evidence seems conclusive as to the improvement of alfalfa rations of narrow nutritive ratios (about 1:4) through the introduction of silage made from low-protein crops, like Indian corn and milo; even the ration containing Sudan grass silage was improved in efficiency when this silage was replaced by corn silage and the nutritive ratio thereby widened from 1:5.1 to 1:5.8. When the nutritive ratio in case of the sweet-sorghum silage experiment was made wider, however, by replacing this silage by Indian corn silage, no improvement in returns per unit of dry matter eaten was obtained. In this

case the nutritive effect of the rations was approximately the same, or slightly in favor of the narrower nutritive ratio (sweet sorghum silage). It cannot be stated definitely from the evidence furnished by these experiments which one of the two factors, the wider nutritive ratio or the succulency of the silage rations, was of greater importance in improving rations composed of alfalfa only or alfalfa with a small amount of grain feed. Probably both contributed in a measure to the result obtained; other contributing factors may have been the favorable influence of the silage acids on the digestion and health of the cows, the variety of protein substances furnished in the corn, etc. Numerous feeding experiments with dairy cows have shown, however, that the composition of the rations, so far as the relation between protein and starchy components goes, is a most important factor in influencing the milk secretion of cows, and that the nutritive ratio of alfalfa or rations made up essentially of this crop is, as a general rule, too narrow to produce the best results as regards milk secretion or returns for feed materials consumed. A widening of the nutritive ratio, which is secured through the addition of low-protein grain feeds or roughage, may, therefore, be confidently expected to bring about an improvement in the results obtained with the dairy herd.[6]

Such a widening of the nutritive ratio in case of alfalfa rations will also bring these closer to that of accepted feeding standards for milch cows. These are the outcome of studies of carefully conducted feeding experiments in which the effect of rations of varying nutritive ratios have been compared. An increasing number of dairymen in this and other western states are every year supplementing alfalfa rations for their cows with either low-protein concentrates or with silage made from Indian corn, sorghum, milo, or similar crops, a fact that furnishes the best evidence that such a change in the feeding practice has been found to produce good and economical returns.

The preceding remarks should not be interpreted to mean that the method of exclusive alfalfa feeding to dairy cows is always to be avoided. The relative prices of dairy feeds are all-important, and when alfalfa hay, as is often the case in this state, is the cheapest forage crop available, it may be fed to advantage, except in the case of high-producing dairy cows that can only be brought to a maximum production through the addition of concentrates to the ration. Where low-protein feeds can be provided, better results may in general be secured than from exclusive alfalfa feeding. Such low-protein feeds can be supplied more cheaply in the form of silage from Indian corn,

[6] Bulletin 256, California Experiment Station, p. 444.

sorghum varieties, Sudan grass, etc., than grain feeds at present or prospective market prices for feeding stuffs, and for milk cows of average or only fair productive capacities, more economical results will be secured by introducing them as a supplement to the alfalfa rations than by feeding grain. Grain feeds, with or without silage, will, however, be found necessary in order to secure the best results in the case of good dairy cows, both amount and economy of production being considered. High-producing cows yield the largest profit to the dairyman, even though the feed they eat may cost considerably more than that of average dairy cows.[7]

SUMMARY

Experiments with silage crops conducted at the University Farm during the past four years have shown that average yields of ten to fifteen tons of green forage may be secured on grain land receiving one irrigation, in case of the following crops: Indian corn, sweet sorghum, milo, feterita, and Sudan grass. When cut at the right time (about time of maturity for Indian corn; when fully matured for the other crops) and carefully packed in the silo, all these crops and doubtless other forage plants belonging to the same families will produce silage of excellent quality and palatability and will furnish succulent feed of special value for feeding dairy and beef cattle, as well as sheep, during late summer or the winter season.

Through the addition of Indian corn silage or milo silage to rations of alfalfa hay, or alfalfa with grain feeds, an increase in production amounting to 10 to 25 per cent was secured in feeding experiments with cows in the University dairy herd, and the efficiency of the rations per unit of dry matter furnished was improved about 10 per cent. Rations of alfalfa hay, with or without grain feeds, supplemented by Indian corn silage, Sudan grass silage, or sweet-sorghum silage, produced similar amounts of milk and milk components. Per unit of dry matter furnished in the rations, those containing sweet sorghum silage proved slightly more efficient than the rations containing Indian corn silage, which in turn proved about 10 per cent more efficient than the rations containing Sudan grass silage.

---

[7] Wisconsin Experiment Station Bulletin 226, p. 24; Research Bulletin 26, p. 63; Massachusetts Station Bulletin 145, pp. 28–29.